

# ANNALES

*Anali za istrske in mediteranske študije*  
*Annali di Studi istriani e mediterranee*  
*Annals for Istrian and Mediterranean Studies*  
*Series Historia Naturalis, 30, 2020, 2*





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## AFTER MORE THAN FORTY-FIVE YEARS A NEW FINDING OF *CYSTOSEIRA FOENICULACEA* F. *LATIRAMOSA* IN THE COASTAL SEA OF SLOVENIA

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### ABSTRACT

Canopy-forming macroalgae, especially *Cystoseira* sensu lato species, create so-called brown algal forests, which are among the most productive habitats in shallow coastal waters. In the Mediterranean Sea these species have been disappearing over the past two decades due to multiple anthropogenic pressures, and are gradually being replaced by smaller and persistent turf-forming algae. A decrease in the number of species and in the cover of canopy-forming taxa (especially *Cystoseira* s.l. spp.) has been detected over the last ten years also in Slovenian coastal waters. This paper reports a recent finding of *Cystoseira foeniculacea* f. *latiramosa*, which was missing from Slovenian marine waters for more than four decades.

**Key words:** *Cystoseira foeniculacea* f. *latiramosa*, new finding, Slovenian sea

## DOPO OLTRE 45 ANNI UN NUOVO RITROVAMENTO DI *CYSTOSEIRA FOENICULACEA* F. *LATIRAMOSA* NELLE ACQUE COSTIERE DELLA SLOVENIA

### SINTESI

Le macroalghe che modellano la canopia, in particolare le specie di *Cystoseira* sensu lato, formano le cosiddette foreste di alghe brune, considerate tra gli habitat più produttivi nelle acque costiere poco profonde. Negli ultimi due decenni queste specie stanno scomparendo dal Mediterraneo e vengono gradualmente sostituite da alghe più piccole e persistenti, che formano un tappeto chiamato turf, a causa delle molteplici pressioni antropiche. Anche nelle acque costiere slovene negli ultimi dieci anni è stata registrata una diminuzione del numero di specie e della copertura dei taxa che formano la canopia (soprattutto *Cystoseira* s.l. spp.). L'articolo riporta il recente ritrovamento di *Cystoseira foeniculacea* f. *latiramosa*, che mancava dalle acque marine slovene da più di quattro decenni.

**Parole chiave:** *Cystoseira foeniculacea* f. *latiramosa*, ritrovamento, mare sloveno

## INTRODUCTION

Along Mediterranean rocky coasts, canopy-forming brown *Cystoseira sensu lato* species (Orellana *et al.*, 2019) play an important role as habitat-builders (Gianni *et al.*, 2013; Blanfuné *et al.*, 2019). They form so-called brown algal forests, which are considered among the most productive assemblages in the Mediterranean basin, providing high primary production, food sources, settlement substrata, and shelter for coastal fish assemblages, diverse smaller algae and invertebrates (Orlando-Bonaca & Lipej, 2005; Ballesteros *et al.*, 2009; Pitacco *et al.*, 2014; Bianchelli *et al.*, 2016).

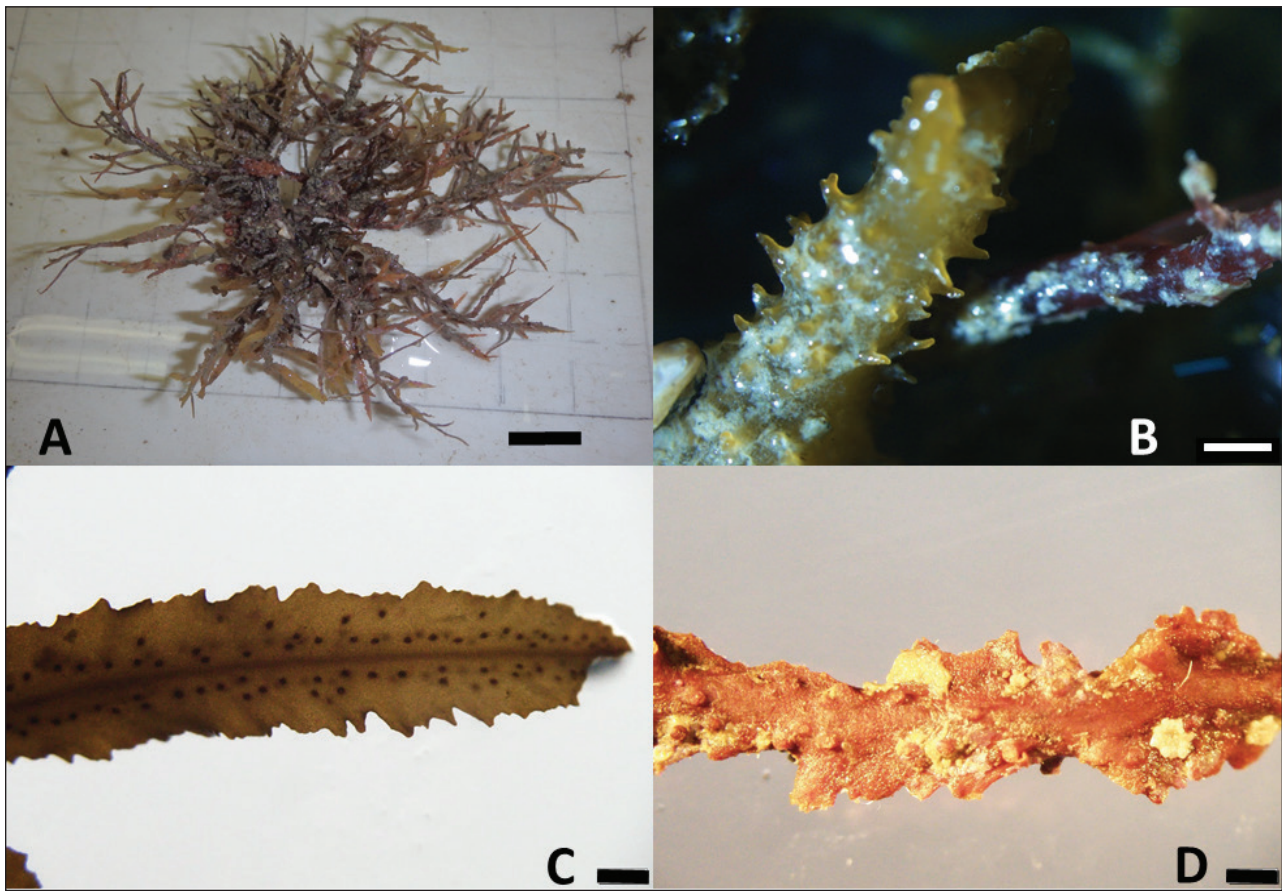
Forty-one taxa of long-living *Cystoseira s.l.* spp. have been reported for the Mediterranean Sea (Taşkin *et al.*, 2012; Cormaci *et al.*, 2012). With the exception of *Cystoseira compressa* (Esper) Gerloff & Nizamuddin, all *Cystoseira s.l.* spp. are included in Annex II (List of endangered or threatened marine species in the Mediterranean) of the Barcelona Protocol concerning Specially Protected Areas and Biological Diversity

(UNEP, 2019), and in Annex I of the Bern Convention (Council of Europe, 1979).

Especially in the past two decades, many scientists have evaluated the impact of interacting anthropogenic local stressors on coastal ecosystems (Airoldi & Bulleri, 2011; Catra *et al.*, 2019). The disappearance of *Cystoseira s.l.* species from shallow rocky bottoms is considered an indication of severe environmental degradation (Iveša *et al.*, 2016; Rindi *et al.*, 2018). Due to incessant anthropogenic pressure, *Cystoseira s.l.* spp. are very often replaced by smaller and less complex algae defined as turf-forming taxa (Perkol-Finkel & Airoldi, 2010). These low-lying algae form a permanent stable state on the bottom, which inhibits the recolonization by canopy-forming species (Gorman *et al.*, 2009; Connell *et al.*, 2014). Some *Cystoseira s.l.* species have already been driven to regional extinction (Thibaut *et al.*, 2015), and despite the implementation of substantial conservation measures, numerous degraded brown algal forests in the Mediterranean Sea have not recovered (Thibaut *et al.*, 2005; Perkol-Finkel & Airoldi, 2010).



**Fig. 1: Sampling site Rex1 between Koper and Izola, where three thalli of *Cystoseira foeniculacea* f. *latiramosa* were recorded.**  
**Sl. 1: Vzorčno mesto Rex 1 med Koprom in Izolo, kjer so bile opažene tri steljke vrste *Cystoseira foeniculacea* f. *latiramosa*.**



**Fig. 2:** *Cystoseira foeniculacea* f. *latiramosa* (Slovenia, July 2020, depth range: 3.7-4.3 m). **A.** Habit (scale bar = 2 cm). **B.** Spinose apex (scale bar = 1 mm). **C.** Toothed margin and prominent midrib (scale bar = 1 mm). **D.** Base of the branches (scale bar = 1 mm).

**Sl. 2:** *Cystoseira foeniculacea* f. *latiramosa* (Slovenija, julij 2020, globina: 3,7-4,3 m). **A.** Videz steljke (merilo = 2 cm). **B.** Trnast apikalni del (merilo = 1 mm). **C.** Nazobčan rob in vidna srednja linija (merilo = 1 mm). **D.** Spodnji del veje (merilo = 1 mm).

Over the past ten years, negative changes in macrophyte spatial and seasonal diversity and a loss in the cover of canopy-forming taxa (especially *Cystoseira* s.l. spp.) have been detected in Slovenian coastal waters as well (Orlando-Bonaca & Rotter, 2018). Still recurrent in the infralittoral belt are *Treptacantha barbata* (Stackhouse) Orellana & Sansón and *C. compressa*, while other species of this group are already rare. Among the actions planned within a research project related to the evaluation of the status of Adriatic brown algal forests (ARRS, J1-1702) were also to verify the status and distribution of brown algal forests in Slovenian coastal waters, identify the causes of their regression, and propose conservation measures. The current paper reports a recent finding of *Cystoseira foeniculacea* f. *latiramosa* (Ercegovic) A. Gómez Garreta, M.C. Barceló, M.A. Ribera & J.R. Lluich, a species that was missing from Slovenian waters for over four decades.

## MATERIAL AND METHODS

The study area is located in the Gulf of Trieste, which is a shallow semi-enclosed embayment extending from Cape Savudrija (Croatia) to Grado (Italy) and comprising the entire Slovenian Sea. Non-destructive SCUBA visual surveys were performed during the years 2019 and 2020 along the rocky coastline, where brown algal forests are still present, within a depth range of 1 m to 10 m. Three thalli of *C. foeniculacea* f. *latiramosa* were found and one was collected on July 27, 2020 at sampling site Rex1 (Fig. 1), in a depth range between 3.7 m and 4.3 m. The plant is stored in the collection of the Marine Biology Station in Piran.

## RESULTS AND DISCUSSION

Originally documented in the Adriatic Sea by Ercegović (1952), *C. foeniculacea* f. *latiramosa* had been



reported in Slovenian waters only once, in the Strunjan Bay in the year 1972 (Avčin *et al.*, 1973). Since 1929, it has been found along western and eastern Mediterranean coasts (historical and newer records reported in Cormaci *et al.*, 2012; Rodríguez-Prieto *et al.*, 2013; Bouafif *et al.*, 2014), but nowadays it is considered rare and endangered, and has already disappeared from some Mediterranean areas (Thibaut *et al.*, 2015). Iveša & Devescovi (2015) reported of some small thalli of the species found along the nearest western Istrian coast of Croatia, but just a year later (Iveša *et al.*, 2016) they only reported the presence of *Cystoseira foeniculacea* f. *schiffneri* (currently accepted as *Cystoseira schiffneri* Hamel).

In summer 2020, three thalli of *C. foeniculacea* f. *latiramosa* were found growing in a biocenosis of a photophilic infralittoral algal community on rocky substrate, at site Rex 1 (Fig. 1). These arborescent and epilithic thalli were attached to the rocky substrate by an irregular holdfast. The plant presented as caespitose, up to 15 cm high, with a light to dark brown colour (Fig. 2). The erect axes were cylindrical and spinose, the apices prominent and spinose. Branches were flattened, with a toothed margin and a prominent midrib. Aerocysts and receptacles were not observed. Despite the lack of reproductive organs, the thalli found matched well with the original classification of *C. foeniculacea* f. *latiramosa* (Ercegović, 1952, p. 93, pl. XXVIIa, as *C. discors* subsp. *latiramosa*), and with later reports (Cormaci *et al.*, 2012; Bouafif *et al.*, 2014).

Although *C. foeniculacea* f. *latiramosa* was previously reported as a typical deep-sea form (from depths over 30

m) (Ercegović, 1952; Rodríguez-Prieto *et al.*, 2013), the thalli collected in Slovenian waters were found growing in the upper infralittoral belt, in low-light conditions due to the high resuspension rate of sediments in this area (Orlando-Bonaca *et al.*, 2015).

According to the requirements of the Water Framework Directive, a regular monitoring programme for macroalgae has been in progress in Slovenian coastal waters since 2006 (Orlando-Bonaca & Rotter, 2018). Additional samples of macroalgae were collected for various research projects from the seventies of the last century to up to the present day, in a depth range from 1 to 8 m. Since *C. foeniculacea* f. *latiramosa* was never found in any of these samples, we assume the species may have reappeared recently. Given the high relevance of *Cystoseira* spp. and due to their confirmed rapid regression in the Mediterranean basin, every new record (of recolonization or extension of the area) of rare or endangered *Cystoseira* spp. is important in view of the preparation of conservation and restoration measures.

#### ACKNOWLEDGEMENTS

The authors acknowledge the project (Factors affecting Adriatic brown algal forests and solutions for habitat restoration, J1-1702) was financially supported by the Slovenian Research Agency. Special thanks are due to dr. Lovrenc Lipej and Milijan Šiško for their help during the fieldwork. We also thank two anonymous reviewers for useful comments and suggestions.

NOVA NAJDBA VRSTE *CYTOSEIRA FOENICULACEA* F. *LATIRAMOSA* V OBALNEM MORJU SLOVENIJE PO VEČ KOT ŠTIRIDESETIH LETIH

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## POVZETEK

Grmičaste makroalge, zlasti vrste iz rodu *Cystoseira* (v širšem smislu), tvorijo tako imenovane gozdice rjavih alg, ki so med najbolj produktivnimi življenjskimi okolji v plitkih obalnih vodah. V zadnjih dveh desetletjih vrste iz tega rodu hitro izginjajo v Sredozemskem morju, njih pa zaradi številnih antropogenih pritiskov postopno nadomeščajo manjše in obstojne alge, ki tvorijo nizko blazinasto vegetacijo, znano kot turf. Tudi v slovenskih obalnih vodah smo v zadnjih desetih letih zaznali zmanjšanje števila vrst in pokrovnosti grmičastih taksonov (zlasti *Cystoseira* s.l. spp.). Avtorja poročata o najdbi vrste *Cystoseira foeniculacea* f. *latiramosa*, katere obstoja v slovenskih morskih vodah niso potrdili že več kot štiri desetletja.

**Ključne besede:** *Cystoseira foeniculacea* f. *latiramosa*, nova najdba, severno Jadransko morje

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